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SOIL FERTILITY IN SUGAR CANE LANDS.*

The variations which are shown in the fertility of different soils and even of an apparently uniform soil, are the bugbear not only of the planter who desires to raise a uniform crop, but of the technical officer whose function it is to trace the source of these variations and to suggest a practical remedy. Various aspects of this problem were discussed at the recent International Congress of Sugar Technology at Baton Rouge. Two broad lines of approach to such problems exist, that of using the cane plant itself as a medium for testing, the farm fertility test, and that of chemical analysis. The former is exposed to the criticism that the result only applies to the particular plot on which the experiment is laid out; the latter to the criticism that the sample may not be a true representation of the average soil conditions superficially and, even more doubtfully, in their vertical distribution. The latter criticism is becoming less valid with the introduction of the rapid methods of analysis for the more important factors, by means of which it is possible to plot the variations in those factors even within a single field.

A survey of the whole subject is given by O. Schreiner and M. S. Anderson (1) who discuss the pros and cons of the various methods in common use for the determination of fertility. They devote particular attention to the new rapid methods of chemical test. These are still in their infancy and, as such, lack coordination. While, in some cases, they have been found to give results concordant with the older, but slower, methods of analysis, in others they are erratic, and the time has not yet come for their general employment. The reasons for these discrepancies and of the failure of the crop sometimes to respond in the manner expected on the basis of such tests are discussed.

Biological methods include the well known Mitscherlich and Neubauer pot tests and the *Aspergillus* test. These take longer than the chemical tests before an answer is obtained and experience is required for the interpretation of the results. Field experiments are the most direct method but are time consuming and expensive. They have, however, a direct appeal to the farmer.

* A Symposium by H. M. L. in *The International Sugar Jl.*, Vol. XLI, No. 489, pp. 338-39, 1939.

(1) *Proc.*, p. 650.

The Louisiana industry was founded on the virgin alluvial soils of the "Sugar Bowl", soils rich in organic matter and other plant foods. A century of cultivation has, however, exhausted the fertility and a gradual reliance on fertilizers has developed. An account of the history of this development is given by L. A. Hurst and R. L. Holmes (2). The systematic study by means of fertility trials commenced in 1922 and preceded an intensive study of the soils themselves, which was only undertaken in 1929, though preliminary investigations had been commenced by Stubbs at a much earlier date. The earlier experiments were based on one-tenth acre plots laid out for interpretation by the Schreiner triangle method. Nitrogen has been shown to be the outstanding requirement for the tract. In recent years randomized and replicated plots have been introduced. The serious ravages of disease have been overcome by the introduction of new varieties, but these require to be associated with improved methods of cultivation. Associated with these studies is a more detailed survey of the more important soils of the sugar cane areas and an account of the various types recognized is given by A. M. O'Neal and L. A. Hurst (3). Analytical details of some of the types of soil recognized in this survey are given by N. McKaig, Jnr., and L. A. Hurst (4), and R. L. Holmes and L. A. Hurst (4) correlate the soil characters of these soils as disclosed by analysis with the crop response. As noted above, the primary response is to nitrogen but, as further supplies of nitrogen are added, a better response is obtained from nitrogen plus phosphate and/or potash than from nitrogen alone, though the deficiency in these two latter elements is so slight that analysis does not disclose it.

Both the above methods of determining the fertilizer requirements of the cane plant on the different soils on which it is grown are laborious and efforts to attain a short cut are numerous. Among these are correlations between the amounts of the essential elements in the soil and the amounts of those same elements in the juice. One such effort is described by R. L. Holmes (5), using some 15 fertilizer experiments scattered over the cane-belt of Louisiana. These efforts are complicated by the differential uptake, found also by other workers, of the various elements by different varieties growing under the same conditions. Of the varieties tested, CP 28/11 had a juice much higher in nitrogen and minerals than others but was not used in the comparisons. Other varieties showed no marked differences. No correlation was found between total nitrogen in the soil and in the juice nor between the total exchangeable bases in the soil and ash. Fair correlations were obtained between available phosphate in the soil and free phosphate in the juice as well as between exchangeable potash in the soil and free potash in the juice. N. McKaig, Jnr. and C. A. Fort in a further paper (6) trace the effect of various types of soil on juice quality. The eastern sandy and the eastern black lands tend to produce a juice comparatively high in acidity, ash and phosphate, the latter also in potash, and low in manganese; the Bayou Teche, black land, a juice comparatively high in acidity, ash, phosphate, sulphate, potash and manganese; the prairie soil, one comparatively high in phosphate and low in ash, potash and calcium; the terrace soil, one comparatively high in manganese and low in acidity, ash, phosphate and sulphate; the Bunkie soils, one comparatively low in chloride and manganese.

The same subject, more particularly with regard to phosphorus deficiency, is approached by T. Saito and M. Kenjo by means of water cultures (7). Determinations were made on leaf, stalks and roots separately when the phosphorus deficient plants apparently ceased to grow (at six months). Refractometer Brix, sucrose and reducing sugar content were also determined. The morphological symptoms of phosphate deficiency are a retardation of growth after some six weeks, yellowish-brown colour of the older leaves with early death, length and breadth of leaves reduced, length and diameter of internodes markedly reduced, no production of tillers, longer and more slender roots with a reddish-brown colour. The effect being more marked on the shoot than the root, the root-shoot weight ratio is increased. Physiological differences include a slight decrease in the sucrose content of the juice, a reduction in the percentage of reducing sugars, an increase in the percentage of nitrogen especially in the stalks, a marked accumulation of silica and a very great accumulation of iron. Although the absolute amounts are very low, there is a noticeable difference in the phosphorus content of the green and dry leaves suggesting a re-utilization of this element.

An account of the soils of British Guiana is given by R. R. Follett-Smith (8). The general nature and origin of these soils, both the front lands and the pegasse, are now well known. The point of major interest is the proof afforded that the diseased condition which had been attributed to magnesium deficiency was due to salt toxicity. It is the soils with a high magnesium : lime ratio that are highly saline, while those with a low magnesium : lime ratio are highly acidic.

The value of all analytical work in connexion with field fertility naturally depends on the accuracy with which the sample represents the actual conditions of the field. With a growing reliance on such analytical work, the importance of accurate sampling increases. This aspect is dealt with by H. W. Kerr and C. R. von Stieglitz (9), who discuss the problem in its Queensland aspect under four heads; the influence of past cropping history, the number of borings, the position in the field in relation to cane rows and the depth to be considered. The data cover three major soil types and refer to sites of farm fertility trials and representative farms. In the latter,

(2) *Proc.*, p. 304. (3) *Proc.*, p. 284. (4) *Proc.*, p. 296.
(5) *Proc.*, p. 314. (6) *Proc.*, p. 319.

(7) *Proc.*, p. 347. (8) *Proc.*, p. 326. (9) *Proc.*, p. 664.

comparison is made between land fallowed for six months, carrying a mature plant crop and carrying a mature ratoon crop.

There is found a wide measure of variation in the amounts of available plant food, according to the time of sampling. This is particularly noticeable in the case of potash and pH values, the former showing a steady decline after the fallow and the latter a general tendency to increased acidity. Phosphate, however, shows a reasonable degree of constancy.

The results obtained from 20 borings per 1.5 acres on the farm fertility plots showed a very wide range of values, particularly for the available phosphate (max. 112, min. 11, with average 40 $\pm$ 5.4). Greater concordance was obtained on the red volcanic loam of Bundaberg. These are from relatively uniform blocks.

Erratic results were obtained from borings bearing different relations to the cane row although no fertilizer had been applied. It seems desirable, therefore, to distribute the borings, one in five in the row and the remaining four in the interspace.

Samples were taken for the upper and second 10 in. of the soil and showed variations in the relative proportions of plant food dependent on soil type.

It is not claimed that these results indicate any specific method for sampling soils but they do show the wide variations which may occur even in soils that are relatively uniform and the need for sampling in such a way that assurance is gained that the sample is truly representative.

The authors are clearly no believers in the rapid methods of analysis. They point out that the collection of representative samples constitutes by far the longer process and consider it illogical to strain at the gnat of detailed analysis giving accurate, instead of approximate, results after swallowing the camel.

B. Campbell appears to hold opposite views for he describes his experience with the R.C.M. methods of Hawaii as applied to South African soils (10). The nature of the difficulties encountered and the manner in which these have been overcome are described.

(10) *Proc.*, p. 617.

JELLY STRENGTH, VISCOSITY AND COMPOSITION OF VARIOUS PECTINS.

Although many workers have insisted that an adequate methoxyl content is a pre-requisite of jelly formation by a pectin, recent developments indicate that no single constituent of the pectin complex is a criterion of jellying ability. The essential part of the pectin complex consists of a long chain of galacturonic acid units. Since viscosity is a measure of molecular size and since viscosity and jelly strength are related, it is highly probable that jelly strength is a function of molecular size, or a chain length of the essential constituent. The following is a summary of an attempt which has just been made by E. W. Bennison and F. W. Norris (*Biochem. Jr.* 33, 1443, 1939), to correlate jelly strength with viscosity, and chemical composition with both, in the case of pectins prepared from different sources by different methods.

As a preliminary to jelly strength tests on prepared pectins, the effect of drying treatment was first examined. When a number of samples of the same commercial citrus pectin were dried for varying periods in an oven at 98°F., they were found to suffer a serious loss in jelly strength. Prior to examination, the products were therefore dried in a vacuum desiccator at room temperature.

As a result of jelly strength tests on pectins prepared from different sources and by different methods the following two facts were observed: first, no beet pectin gave a jelly and secondly, no pectin prepared by autoclave extraction would yield a jelly. A comprehensive analysis of twenty-one samples of pectin prepared by different methods from orange peel, apple and beet, showed that the relation between chemical composition and jellying ability is not very definite. Although no definite generalizations can be made, it appears that a high urone content favours jelly formation, and, conversely, a high content of non-urone constituents (arabinose and galactose) inhibits jelly formation. No pectin with less than about 68 per cent. urons gave a jelly, whilst the most satisfactory sample in regard to jelly strength was a commercial sample of citrus pectin which had a urone content of 86.56 per cent. and an arabinose content of less than 1.0 per cent. No relation was found between jellying ability and the methoxyl content of pectin.

In an attempt to correlate jelly strength and viscosity, and viscosity and chemical composition for pectins from different sources, prepared by different methods, it was found that, although proportionality between jelly strength and viscosity may hold for one particular pectin submitted to varying degrees of heat treatment, it is by no means certain that the same holds for different pectins prepared by different methods. There is no direct relationship between jelly strength and viscosity for various pectins, but there is a certain parallelism. It appears that there is a limiting viscosity below which jelly formation does not take place, but at the same time, the viscosity may be above this limit and the pectin still fail to give a jelly. This latter phenomenon may be explained by the presence of contaminating substances in sufficient quantity to prevent jelly formation. As in the case of jelly strength, it is impossible to draw definite conclusions with regard to the relation of chemical composition and viscosity. The method of preparation and the material used are factors at least equal in importance to composition of the products. In short, the power of pectin to form jellies depends to some extent on composition, but primarily on molecular size, as indicated by viscosity. Any pre-treatment which tends to disaggregate the polygalacturonide chain tends also to cause loss of jelly strength.

H.F.B.

THE WORK OF THE BRITISH WEST INDIES PLANT QUARANTINE STATION FROM 1934 TO 1939.*

By A. M. Adamson,
(*Officer-in-Charge and Entomologist*)
And R. E. D. Baker,
(*Mycologist*).

The British West Indies Plant Quarantine Station is situated in the grounds of the Imperial College of Tropical Agriculture, about seven miles from Port-of-Spain, in the island of Trinidad. It serves all the British West Indian islands and also British Guiana and British Honduras. It is managed by an advisory committee of eight members, including the Director of Agriculture of Trinidad and Tobago, who is the Chairman, the Principal of the Imperial College and the Commissioner of Agriculture for the Windward and Leeward Islands. The executive officers of the Station are the heads of the Departments of Entomology and Mycology of the Imperial College, both of whom are members of the committee. In addition to managing the affairs of the Station, the committee acts in an advisory capacity on matters of plant quarantine within the West Indian area. It has made a special study of the problems of legislation, as a result of which a model Plant Protection Ordinance, drawn up in consultation with the Colonial Office, has recently been sent by the Secretary of State to the governments of all British West Indian colonies. In all of its work the Station co-operates closely with the Trinidad Department of Agriculture.

Capital expenditures of the Station have been met by special grants from the Colonial Office and the costs of maintenance by contributions from the colonies which it serves.

The Station consists of two glasshouses, one divided into nine rooms, the other into five. Each room can be used as a separate unit, so that if a disease or pest develops in any one of them its contents can be destroyed without affecting the other rooms. It has also an inspection chamber, equipped with a vacuum fumigator, opening directly into the larger house, and a potting shed containing the soil sterilising plant. Since they were built the houses have had to be considerably altered. At first they had only small gauze-covered windows in the roof, and consequently became very hot and dry; but now that some of the glass has been replaced by wire gauze, and water-sprinklers have been installed in all the rooms, a much more suitable environment for plants has been produced. The temperature of the rooms now seldom rises much above 95°F., and the humidity can be maintained at a suitable level by means of fine sprays of water from the sprinklers installed near the roof of each room.

All plants are grown in tins in a soil made up of one-third coarse sand, one-third earth, and one-third fine compost or manure. The soil is sterilised by steam both before and after use. The plants are watered heavily two or three times a week rather than lightly each day. Thrips of several species and red-spiders, which cannot be altogether excluded, are capable of multiplying extremely rapidly on plants growing in the hot dry atmosphere of a glass house in the tropics, and have to be controlled by routine sprays of nicotine and sulphur.

Much has been learnt during the five years in which the Station has been in operation, and regular routine treatments have been worked out for most of the material handled. The chief plants received at the Station are sugar cane, cotton, cacao, bananas and citrus. The following notes are given on the methods of handling planting material and on the difficulties experienced.

Sugar Cane.

All the sugar canes bred or imported by the B. W. I. Central Cane Breeding Station in Barbados are quarantined here in addition to other canes ordered by the various West Indian Departments of Agriculture. Many varieties have been very generously supplied by the plant quarantine station of the U. S. Department of Agriculture in Washington, and some by the Imperial Sugar Cane Station at Coimbatore. At first all canes were grown in the houses for three vegetative generations, a process requiring about eighteen months, but the quarantine period has recently been reduced to one generation in the case of canes originating in Barbados and Trinidad or from recognised quarantine stations in other countries. For some time the canes did not grow well and were seldom thick enough for export. After a series of experiments with different soils, sun-shades and water sprays, a satisfactory technique was developed. The canes grow best in full sunlight in any good soil provided that the atmospheric humidity is kept up. This is done by means of a water spray in the rooms on sunny days. Thrips (*Hercothrips insularis*) and red-spiders thrive on the canes, unless kept down by spraying. Cane cuttings can be shipped almost any distance provided that the ends are waxed and they are packed in damp, powdered charcoal. Particular attention is paid to precautions against the spread of gumming disease, which occurs in Barbados but is absent from certain other West Indian colonies. Fortunately it is easy to prepare canes for export without any possibility of infestation by the Sugar Cane Froghopper (*Tomaspis saccharina*), which occurs only in Trinidad and Grenada. Few insects have been intercepted on canes received from abroad and no foreign disease has appeared on plants in the quarantine houses.

* Paper submitted to the Imperial Mycological Conference.

Cotton Seed.

Much cotton seed is received and distributed for the Cotton Research Station in Trinidad and a very satisfactory technique has been developed. Seed is treated on arrival with strong sulphuric acid and then heated to 60°C. for half an hour. It is then grown for one generation in a special quarantine house at the Cotton Station. If necessary, it is also fumigated. Seed to be sent away is heated or fumigated but is not treated with sulphuric acid. A considerable number of foreign insects, including bollworms, have been intercepted. The Plant Quarantine Committee has devoted much time to legislation to prevent the spread of the Cotton Boll Weevil (*Anthonomus grandis*) into the British West Indies. This weevil was introduced long ago from the American mainland to Cuba and in 1933 it was discovered in Haiti. It has become extremely destructive there and its further spread into the Lesser Antilles might put an end to the commercial production of cotton in these islands.

Bananas.

Bananas and related plants are regularly received from Kew and are grown for one vegetative generation in the Quarantine Station. They grow well and seldom give any trouble. Intercepted insects include the aphid, *Pentalonia nigronervosa*, which is the vector of Bunchy-top disease, and termites of the genus *Amitermes* in a banana sucker from Central America.

Cacao.

Cacao is rarely handled at the Station. Some budwood received from Ecuador was successfully raised in the greenhouses, and seedlings of wild species have been grown for some time prior to their release. The large quantities of cacao collected by Dr. F. J. Pound in South America are being quarantined in Barbados, an island which grows no cacao, and are being introduced into Trinidad as budwood. This procedure was adopted to obviate any risk of introducing *Monilia* pod-rot or any other unknown South American disease or pest into Trinidad. All budwood received from Barbados has been entirely free from insect pests.

Citrus.

Buds of a South African variety of grapefruit were successfully worked on to local sour orange stocks in the houses and grown for two vegetative generations before budwood was released from the Station. This procedure took about two years and will be followed in future with all citrus budwood introductions. Supplies of seed of sour orange and rough lemon have been sent to some of the Lesser Antillean islands; inspection during preparation of shipments ensures freedom from diseases and pests.

Seeds.

Packages of seeds are handled frequently. Seed from reliable firms of seedsmen is not examined at the Station. Other seeds are treated on their merits. Some are released without treatment, but where the presence of insects or fungous disease is suspected they are fumigated or treated with formalin.

Miscellaneous Plants.

Small quantities of other plants, such as coffee, mango, pineapple, derris (*Lonchocarpus*) and some ornamentals, have been grown in the quarantine houses. Other crops of which planting material has been passed after examination and treatment include rice, maize, sorghum, coconut, tobacco, avocado, sweet potato and yam. All consignments sent from the Station to other countries are accompanied by a certificate, signed by the mycologist and the entomologist, stating that no signs of disease or pests were found on the material.

Now that the early difficulties of the Station, which were chiefly those connected with the satisfactory growth of plants in a closely screened greenhouse in a tropical climate, have been overcome, the Station is functioning satisfactorily. During the past five years some potential insect pests have been intercepted, but no foreign diseases or insects have appeared on any plant growing in the quarantine houses. It is felt that much useful work has been done and that the Station is a powerful factor in preventing the introduction or spread of new diseases and pests in the West Indies.

WHEN TO PRUNE COFFEE.

According to an article by S. Gillett which appeared in *Mon. Bull. Coffee Bd. Kenya*, 1939, V, 38, the pruning of single-stem coffee should be deferred until the flower buds for the next crop are definitely formed. At the end of crop, however, a light handling should be given to ensure a fairly open tree, to assist the season's growth and to render pest control easier. This advice does not concern trees that have overcropped and are in a state of dieback; these should be left to recover naturally. Nor does it concern trees that, having borne no crop, have produced new wood and early flower buds; such trees can be pruned or handled earlier and by so doing the pressure of work, which will occur when the delayed pruning takes place, will be somewhat reduced. Multiple-stem trees should also not be pruned until after flower bud formation but the problem is not complicated by the necessity of producing the right type of cropping wood.—(*Hort. Abs.*, Vol. IX, No. 2, June, 1939.)

WITCHES' BROOM RESISTANCE IN CACAO.*

By F. J. Pound.
(*Department of Agriculture of Trinidad and Tobago.*)

I. Introduction.

Witches' Broom disease of cacao is caused by the Basidiomycete fungus *Marasmius perniciosus* Stahel. First reported from Surinam in 1895, it appeared subsequently in Ecuador about 1918, in Trinidad in 1928, and in Tobago quite recently. The degree of infection in the upper tributaries of the Amazon, and such information as can be obtained from Indians in that region, suggest that the disease was present in the Amazon valley long before it was reported in Surinam. It has now spread to the lower reaches, but its arrival there must be subsequent to the wholesale shipping of planting material to the Bahia district when the cacao industry in that area was started.

The fungus can only infect young growing tissues, hence, in the early stages of infection, it manifests itself as twig infections which show swellings and stimulation of lateral buds to form 'brooms'. Inflorescence buds may also be attacked and stimulated to grow either into the common vegetative brooms, or into 'star' brooms, in which a mass of flowers with thickened pedicels is produced. Fruit of all ages can be attacked. Pods attacked very young become deformed and die, while those which are attacked later come to maturity but produce no marketable beans. Thus, although the disease does not directly kill the cacao tree it can, if left unchecked, prevent it from bearing.

II. Control.

Early work in Surinam, and subsequent experiments on a much more comprehensive scale in Trinidad, have failed to find any better method of control than the frequent removal of the diseased tissues first advocated by Stahel. From the earliest stages, therefore, search has been made for immune trees.

In Surinam, the rather uniform Amelonado type of cacao in cultivation did not show any immune trees. In Ecuador, the promise of a reward stimulated the search, and in a short time some thousands of supposed immune trees were reported. In some cases these were trees which remained healthy when acres around were severely attacked by the disease. Seedling progeny from these trees was multiplied rapidly after 1928 and in 1937 there were estimated to be 1½ millions of resistant or immune trees. On closer examination the parent trees proved not to be entirely immune and the seedling progeny showed all degrees of infestation. Some 10-20 per cent. however, were estimated to have sufficient resistance for practical purposes.

These resistant trees found in Ecuador did not belong to the local 'Nacional' variety of cacao, but were called 'Venezuelan', and their name, together with records of introductions of planting material from Trinidad, suggested that similar resistance might be found in the Trinidad cacao population, which is similar genetically to that of Venezuela. The search for immune trees in Trinidad was therefore undertaken on a large scale, but although it revealed more variation in susceptibility than could be explained by variation in size of tree and locality, no complete immunity was found. In heavily infected areas the only trees which did not have the disease were old and unthrifty and probably had done little flushing during the previous five years.

In 1937 the writer went to Ecuador to examine the immunity or resistance of the so-called Trinidad types on the spot. He was struck by the fact that all the trees which showed outstanding resistance were bearing unpigmented pods of types not common in Trinidad. From this observation he concluded that the introductions from Trinidad were not the only ones made into Ecuador, and that other unrecorded introductions had been made, possibly from the Amazon basin east of the Andes. This seemed all the more likely since the resistant types were all concentrated in Southern Ecuador, near the easiest point for crossing the Andes.

Shortly afterwards the writer made an expedition up the Amazon to the head-water tributaries, and was able to confirm his conclusion. On the way, signs of resistance were found on the lower Amazon below Manaos where an occasional tree could be found with little or no infection. The cacao population appeared to be a hybrid mixture, with an Amelonado type like that in Surinam as one parent. It was noteworthy that trees found without the disease were all fully exposed to the sun, and no signs of resistance were found in plantations where the trees were shaded, indicating that an ecological factor rather than genetical resistance was of major importance.

A complicating factor here was the presence of Cupuassu trees (*Theobroma grandiflorum*) which were invariably heavily infected, and seemed to act as reservoirs of infection for any cacao trees growing around them.

Above Manaos the type of cacao changed and there was less evidence of the Surinam Amelonado variety in the population. At the same time the signs of resistance became so obvious as to be beyond doubt. Furthermore, not a single pigmented pod type was found.

Between Manaos and Iquitos cacao occurred more or less wild. Usually where villages occurred there was a fringe of trees on the river bank, which were shaded by forest trees, and, in the savannah country behind there were odd groups or single cacao trees. As in Ecuador and Trinidad, the shaded trees showed every degree of infection,

* Paper submitted to the Imperial Mycological Conference.

but while the majority of the fully exposed trees were more than ordinarily infected an occasional one would be found free from the disease. Such occurrences became more frequent as the expedition worked its way to Iquitos. At the same time the Surinam Amelonado type had completely disappeared.

On the strip of land between the Rio Nanay and the Amazon a quantity of cacao of a very consistent type was found. Inspection revealed intense infection, the most severe met with up to that time, but at one point trees were found with no disease, and these stood out because they alone were laden with pods. A tree-to-tree search revealed some fourteen trees with no disease, intimately mingled with many others which were heavily infected. These uninfected trees were not restricted to growing in the open and looked as though they, in common with infected trees around, might all have come from one parent. This Nanay type appeared very similar to, if not identical with, a special resistant type being propagated in Ecuador on Hacienda Amalia.

On the large island opposite Iquitos an unpigmented Calabacillo type predominated and there again one group of trees was found in which a few individuals showed no infection.

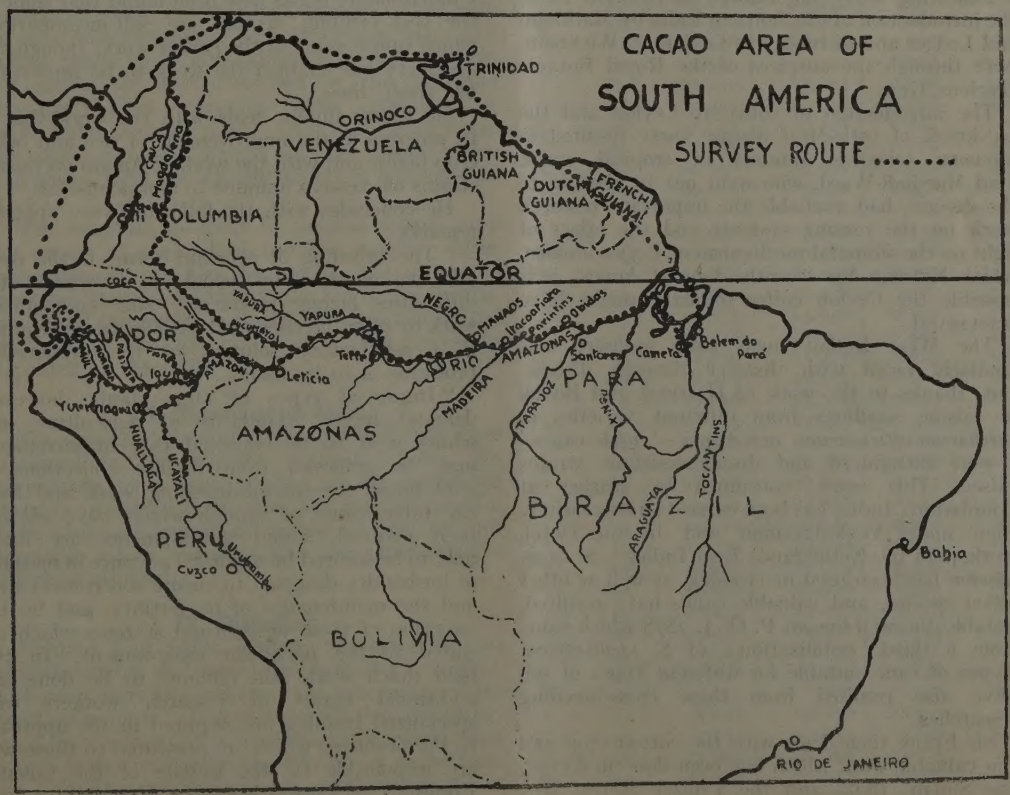
On the Rio Marañon a third type was found. This was, as far as could be seen, identical with the most resistant type in South Ecuador, now only about two hundred miles to the west; which confirmed the previously formed theory that the resistant Ecuador types came from this region.

The search was continued westwards to the foothills of the Andes and there, on the northbound Rio Huallaga, cacao 'Nacional' was reached and thereafter no further signs of resistance were encountered.

Turning south, on the Ucayali, much less cacao was found but in the open, trees bearing long warty unpigmented pods were found free of disease.

So little cacao was seen on the Rios Napo and Putumayo and the little that was found was so heavily infected that no intensive search was made on these rivers. Higher up in the Cordilleras on the Rio Ortegaza, slightly pigmented blanco Calabacillo types were found heavily infected.

In the upper waters of the Rio Magdalena and in the Rio Cauca valley at altitudes of over 3,000 feet Criollo cacao is indigenous and is completely free from Witches' Broom, although planting material from the heavily infected coastal plains around Tumaca has been introduced without restriction until recently. The absence of the disease in the upper Cauca valley has been confirmed by a recent intensive survey by the Colombian authorities.



Several important questions arise from these observations. In particular, the interactions of genetical resistance and ecological factors obviously need further study. Firstly, it is clear that, in some varieties at least, the inherent resistance is only expressed in open situations. The lack of infection in full sunlight may be due to the more rapid hardening or cuticularisation of young tissues; the practical question is whether resistant cacao should in future be grown with as little overhead shade as possible. Secondly, the absence of Witches' Broom in the upper Cauca valley suggests that altitude may be another ecological factor influencing the incidence of the disease, possibly through inability of the parasite to thrive at high altitudes. It would be interesting to know whether this is the factor preventing the rapid spread of Witches' Broom on the Northern Range of Trinidad. Thirdly, there is the very important question whether the types on the upper Amazon, found uninfected even under shade, are completely immune or not. Similar types in Ecuador were only highly resistant. More will be known about this in a year or two, as the seedling progeny of these trees were planted in the testing nurseries in Trinidad in 1939.

ECONOMIC BOTANY IN THE TROPICS.

Sir Frank Stockdale, in his interesting address, on the "Application of Economic Botany in the Tropics", which had been prepared for the Dundee meeting of the British Association but was not delivered owing to the cancellation of the meeting, points out that many of the economic crop plants now commonly grown in the tropics were distributed when new lands were discovered in Elizabethan times. Tobacco, for example, from tropical America; sugar cane and the banana from the Old World; cacao from Central and South America, and rubber from Brazil. Coffee is indigenous in tropical Africa, and China and Cochin China appear to be the original home of the citrus group.

Following early haphazard distribution came the introduction of Cinchona to India by Markham and Ledger and of rubber to Ceylon by Wickham, both through the auspices of the Royal Botanic Gardens, Kew.

The introduction of coffee to Ceylon and the out break of coffee-leaf disease there resulted in arousing scientific interest in tropical crops. Had Marshall-Ward, who went out to investigate the disease, had available the important research work on the rooting systems and the effect of light on the stomatal mechanism of *Coffea arabica*, which Nutman has recently done at Amani, it is possible the Ceylon coffee industry might have been saved.

The West Indian sugar cane industry was similarly faced with disaster through disease, but, thanks to the work of Harrison and Bovell in raising seedlings from different varieties of *saccharum officinarum*, new types—'noble canes'—were introduced and disease-resistant strains raised. This work, continued by Barber at Coimbatore, India, has been carried on successfully there under Venkataraman and by the Dutch workers in the Netherlands East Indies. *S. spontaneum* has been used in crossing, as well as other allied species, and valuable canes have resulted, notably the well-known P. O. J. 2878 which came from a third 'nobilization' of *S. spontaneum*. Types of cane suitable for different types of soil have also resulted from these cross-breeding researches.

Sir Frank then deals with the cotton crop and the valuable work which has been done in Egypt, the Sudan, India and the United States, &c., which have resulted in marked improvements in yield, lint length and fineness, and strength of lint, while disease resistance has also received much attention with valuable results.

Both cinchona and rubber have been subjected to careful scientific investigation which has led to the recognition of high- and poor-yielding strains, and the selection of high-yielding 'mother-trees' for budding. Hybridizing work on rubber is now being carried out and a search is being made also for strains resistant to the Oidium mildew which is causing serious damage to rubber in the East.

The work now in progress in Trinidad with cacao is fully dealt with and the important discovery of incompatibility in cacao is referred to. Unfortunately it has now been found that some of the best yielding strains are self-incompatible, which upsets some of the earlier work, though the discovery has enabled the work to be prosecuted on fresh lines.

Sir Frank finally deals with the work that is in progress in the improvement of rice and other crop plants and with the work at Amani on raising strains of cassava immune to mosaic disease.

He concludes with the following very apposite remarks:

"The breeding of resistant forms is the most effective method by which to overcome the difficulties facing producers, and co-operative work by plant breeders and pathologists is required if a satisfactory solution of the present-day problems is to be found.

"Improved types of crop plants, however, demand higher standards of agriculture and whilst it is to be expected that improvements may be achieved from further collections of wild forms for special breeding work and from the interchange of strains which have already been evolved, sound developments are likely only to be secured by a general advance in methods of husbandry designed to ensure soil conservation and the maintenance of its fertility, and by the adoption of those agricultural systems which are suited to the particular environment. In this field much work still remains to be done and additional teams of research workers with specialized training are required in the approach to the problems which are presented to those who are responsible for the welfare of the Colonial Empire".—(*Nature*, Vol. 144, No. 3647, p. 563, 1939.)

WEIGHED *vs.* MEASURED MIXED JUICE.

By J. G. Davies,
(*Sugar Technologist, Imperial College of Tropical Agriculture.*)

I. Introduction.

Various aspects of the effect on milling control of calculating the weight of the mill products have already been discussed and published (1), (2). The present paper deals with the weight of the mixed juice. The desirability for accuracy in this weight is evident and fully recognized since together with the sampling and analyses of the sample, it forms the basis of the chemical control. Most factories, however, are not equipped with juice scales and the weight must therefore be calculated from volumes measured *under factory conditions*. The extent and importance of the operating errors inherent in this procedure are discussed herewith.

II. Procedure.

The Experimental Sugar Factory attached to the Department is equipped with an Avery Bin type juice scale. At the normal rate of operation, the bin of about 550 lbs. nett is filled every 5 to 6 minutes. On discharge into a receiving tank, the juice flows by gravity to one of three cylindrical, conical bottom liming tanks. During operation, the time filled, and gross, tare and nett weights are recorded for each bin full. At the liming station, about three tanks are filled per hour and each is recorded, together with the amount of milk of lime and phosphoric acid (if any) added. The liming tanks have been calibrated to the overflow by means of water weighed in the weighing machine. The capacity thus obtained is 38.83 cubic feet per tank. Cold imbibition water is used, and the weight of the mixed juice calculated from the measurements is corrected to 27.5°C.

The weighing machine is checked during crop by means of a standard 100 lbs. weight. After correction at the 100 lbs. mark, the weight is removed and water added to the bin to the 100 lbs. mark and the weight replaced for correction of the machine at the 200 lbs. mark. The process is repeated up the scale.

III. Experimental Data.

The appended data of crops 1938 and 1939 were obtained in the manner outlined above. No corrections have been applied to the calculated weights of mixed juice since the general practice is to adopt a standard correction for lime, air and bagacillo which therefore has the same relative effect on all results.

IV. Discussion.

Column 4 in Table I shows the error in tons introduced by the use of the calculated weights. Column 5 expresses this error as a percentage of the weighed weights. It is to be noted that the difference from day to day is by no means consistent and varies from a maximum negative of −5.96 per cent. on Crop Day 18/1938 to a maximum positive of 10.59 per cent. on Crop Day 29/1938. Omission

Table I.

Weighed and Calculated Daily Weights of Mixed Juice.
I.C.T.A. Experimental Factory, Crops 1938 and 1939.

(1) Crop Day No.		(2) Tons Juice Diluted. Calculated.	(3) Tons Juice Diluted. Weighed.	(4) Tons Difference.	(5) Per cent. Difference on Weighed Weight.
1938	1	23.998	23.524	0.474	2.01
	2	25.937	25.372	0.565	2.23
	3	23.882	23.146	0.736	3.18
	4	22.299	21.775	0.524	2.41
	5	11.258	11.121	0.137	1.23
	6	22.731	21.915	0.816	3.72
	7	24.715	24.644	0.071	0.29
	8	25.515	25.308	0.207	0.82
	9	23.546	23.168	0.378	1.63
	10	23.862	23.849	0.013	0.06
	11	9.357	9.221	0.136	1.47
	12	23.862	23.659	0.203	0.86
	13	22.506	22.120	0.386	1.74
	14	27.390	26.733	0.657	2.46
	15	26.878	26.379	0.499	1.89
	16	23.448	22.437	1.011	4.51
	17	9.177	8.974	0.203	2.26
	18	25.012	26.598	−1.586	−5.96
	19	24.290	24.347	−0.057	−0.23
	20	28.129	28.083	0.046	0.16
	21	29.148	28.946	0.202	0.70
	22	19.502	19.544	−0.042	−0.22
	24	25.259	25.153	0.106	0.42
	25	24.952	25.978	−1.026	−3.95
	26	28.622	28.428	0.194	0.68
	27	24.091	23.362	0.729	3.12
	28	26.036	24.964	1.072	4.29
	29	10.006	9.048	0.958	10.59
1939	1	29.972	28.829	1.143	3.96
	2	26.654	25.286	1.368	5.41
	3	24.745	24.431	0.314	1.29
	4	21.806	21.026	0.780	3.71
	5	14.878	13.650	0.228	1.56
	6	19.338	18.917	0.421	2.23
	7	12.870	12.043	0.827	6.87
	8	28.611	27.751	0.860	3.10
	9	25.126	25.775	−0.649	−2.52
	10	27.489	27.913	−0.424	−1.52
	11	10.526	10.472	0.054	0.52
	12	26.619	26.782	−0.163	−0.61
	13	27.136	27.009	0.127	0.47
	14	25.649	24.846	0.083	0.33
	15	26.322	26.541	−0.219	−0.83
	16	24.359	24.399	−0.040	−0.16
	17	10.672	10.274	0.398	3.87
	18	26.099	25.568	0.531	2.08
	19	27.477	27.206	0.271	1.00
	20	25.076	24.702	0.374	1.51
	21	27.007	26.756	0.251	0.94
	22	28.098	27.262	0.836	3.07
	23	7.937	7.637	0.300	3.93
	24	28.655	28.550	0.105	3.68
	25	24.134	23.944	0.190	0.79
	26	21.968	21.368	0.600	2.81
	27	22.666	22.933	−0.267	−1.16
	28	25.750	25.605	0.145	0.57

in recording a liming tank is eliminated as far as possible because at the start of the day the left-hand one of the three tanks is always filled, and its number in the record book must therefore appear as 1, 4, 7, &c. Similarly the second tank appears as 2, 5, 8, &c., and the third or right-hand one as 3, 6, 9, &c. Checking is carried out consistently during the crop by one of the members of the staff or the student in charge of the factory.

As regards the human element of the operator, the factory is worked by a single day-time shift. One man was in charge of the liming and measuring tanks for the whole of Crop 1938 and another for the whole of Crop 1939. Hence any fluctuations due to this factor during either crop are within the liable error of a single individual, however great or small that may be. Inspection of Table I reveals that the daily fluctuations are of the same order during each crop and therefore with two different individuals. Any part which this factor may play must therefore be regarded as part of the inaccuracies occurring when volumes are measured *under factory conditions*.

Since the daily fluctuations in difference are usually of less importance to chemical control than the weekly fluctuations, the latter are given in Table II.

Table II.

WEIGHED AND CALCULATED WEEKLY WEIGHTS OF MIXED JUICE.

I.C.T.A. EXPERIMENTAL FACTORY. CROPS 1938 AND 1939.

(1) Run No.	(2) Tons Juice Diluted. Calculated.	(3) Tons Juice Diluted. Weighed.	(4) Tons Difference.	(5) Per cent. Difference on Weighed Weight.
1938 1	107.374	104.938	2.436	2.32
2	129.726	128.105	1.621	1.26
3	133.261	130.302	2.959	2.27
4	126.081	127.518	—1.437	—1.13
5	138.966	136.933	2.033	1.48
Totals & Averages	635.408	627.796	7.612	1.21
1939 1	118.055	114.222	3.833	3.35
2	123.960	122.871	1.089	0.89
3	140.757	139.851	0.906	0.65
4	141.694	139.131	2.563	1.84
5	123.173	122.400	0.773	0.63
Totals & Averages	647.639	638.475	9.164	1.44

Mean Difference correction for Crops 1938 and 1939 = 1.32.

The weekly results are displayed in the same manner as the daily ones. The differences vary from a maximum negative of —1.13 per cent. on Run No. 4/1938 to a maximum positive of 3.35 per cent. on Run No. 1/1939. The crop means are 1.21 per cent. for Crop 1938 and 1.44 per cent. for Crop 1939.

In comparing the differences, it is to be remembered that they affect the pol extraction and pol per cent. cane in the milling control, the pol recovered per cent. indicated pol, pol recovered per cent. available pol (B.H.E.) and undetermined losses in the boiling house control and the related figures in the pol balance.

Assuming that similar fluctuations in differences from the true weight are obtained in any factory in which the weight is calculated, the effects may be summarized as follows :

(i) MILL CONTROL.

When the weights of cane and of imbibition water are established, any error in the weight of mixed juice is passed on to the weight of bagasse if the latter is obtained by difference. Since mixed juice is usually of the order of 100 per cent. on cane and bagasse 25 per cent. on cane, each one per cent. error in the weight of mixed juice produces a 4 per cent. error in the weight of bagasse. The pol extraction and pol per cent. cane figures are affected by corresponding amounts.

(ii) BOILING HOUSE CONTROL.

In the control of the boiling house the tons of pol recovered in sugars and the tons of pol lost in filter cake and in final molasses are taken as established. The weight of indicated pol in mixed juice depends directly on the weight of mixed juice. A one per cent. error in the latter therefore produces a one per cent. error in the former. In terms of tons, any deviation from the true weight of pol in mixed juice is passed on directly as such to tons of pol in undetermined losses. When the tons of pol in mixed juice as reported is too low, the pol recoveries and undetermined losses expressed as percentages benefit, *i.e.* the recoveries are artificially increased and the losses decreased. The reverse is true when the tons of pol in mixed juice as reported is too high.

The undetermined losses per cent. pol in mixed juice in the average West Indian factory is of the order of 0.7 per cent. Assume that the tons per 1,000 tons of pol in mixed juice are as shown in Column 2, Table III.

Columns 3 and 4 demonstrate the effect on the pol balance of a one per cent. negative and positive error in weight of mixed juice. The percentages are shown in brackets. It would appear that an error even of this magnitude is able to make considerable differences in the figure appearing in the pol balance. The pol recovered per cent. available pol is affected to the same extent as the pol recovered per cent. indicated pol.

One can therefore but come to the conclusion that for the chemical control to be accurate, weighed weights are essentially necessary. While the installation of weighing machines cannot put any more sugar in the bag, it is at least reasonable to suppose that a loss may be revealed which can be rectified.

Table III.

(1)	(2) Correct weights.	(3) Wt. mixed jc. 1% too low.	(4) Wt. mixed jc. 1% too high.
Tons pol in sugars	910 (91 %)	910 (91.9 %)	910 (90.1 %)
Tons pol in final mols	75 (7.5 %)	75 (7.6 %)	75 (7.4 %)
Tons pol in filter cake	8 (0.8 %)	8 (0.8 %)	8 (0.8 %)
Tons pol undetermined	7 (0.7 %)	−3 (−0.3 %)	17 (1.7 %)
Tons pol in mixed jce.	1,000 (100.0 %)	990 (100.0 %)	1,010 (100.0 %)

Furthermore, important deductions are often made from the figures appearing on the Pol balance as regards plant operation, the effect of different cane varieties and so on. Small variations in recoveries and extractions may be taken as significant, since in terms of tons they represent a large amount of sugar. When the weight of mixed juice is calculated from volume measurements made *under factory conditions*, it would appear that some of these variations can be due to the method of obtaining the weight of mixed juice. Hence recognition must be made of this fact, and conclusions drawn with the utmost caution.

Even if a mean difference correction (1.32 per cent.) for the two crops was applied to the weekly calculated weights, it would still not be possible to eliminate the fluctuations in difference between the calculated weights and the weighed weights. The reason for these fluctuations may be assumed to be due to the varying nature of the juices. When compressed air is used for mixing, the fluctuations may be even greater since they will depend on the amount of air valve opening while the tank is being filled, and the ability of the juice to retain occluded air.

V. Summary.

(*a*) The weight of mixed juice as weighed is compared with the weight as calculated from volume measurements from data obtained at the Experimental Sugar Factory of the College.

(*b*) The methods of calibrating the measuring tanks and of checking the juice scale are described.

(*c*) The differences in the weighed and calculated weights vary from day to day and from Run to Run.

(*d*) The effect of errors in the calculated weights is discussed, together with that of a one per cent. error on the boiling house figures.

VI. Bibliography.

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SYNTHETIC GLYCERIN.

In 1937 the glycerin produced in the U.S. amounted to about 169.4 million lb. of crude and 92.9 of refined, while that imported was about 13.6 million lb. of crude and 7.4 of refined. Immense amounts are used for the manufacture of glycerin, tobacco, cosmetics, &c., as well as in the moulding and coatings industries. It is now also entering into the production of both rayon and cellophane. After having averaged 10 cents per lb. for more than a decade, its price has advanced to 14½ cents (August, 1938), which conditions demand that sources of supply other than the hydrolysis or saponification of fats be investigated. Its cost of production by the fermentation process with blackstrap at 6 cents per gallon approximates 12 cents per lb., but if the production were carried on near the source of supply with its raw material at say 2 cents per lb, costs could be considerably lowered. Probably, however, the investment would be about $800,000 for a 20 million lb. per year plant, besides which it is likely that saponification producers would depress their prices in competition. A yet cheaper method of production is likely to be found in the petroleum oil industry ; in cracking the oil, substantial amounts of olefins are discharged from the stills, and from the debutanizers large amounts of prophylene are obtained. This on chlorination gives 1, 2, 3 trichlorpropane, which hydrolyses directly in alkaline solution to glycerin. One oil refining company has already installed equipment for this process, indicating that the cost of production will be approximately 8 cents per lb., and another concern has erected plant for the utilization of natural gas for the same method of production. (A list of patents relating to the production of glycerin by fermentation and by synthesis are given at the end of this informative article.)—(*Int. Sugar Jr.*, Vol. XLI, No. 490, p. 403, 1939.)

NEW SHADE TREE FOR COFFEE.

Albizzia malococarpa Standley, a small tree of which seeds were brought from Salvador, South America, in 1933 and distributed to the various French African colonies, is giving excellent results in providing light shade for coffee in parts of the Cameroons. It resembles *Leucaena glauca* but the rachis bears a rust-coloured pubescence.—(*Rev. Bot. Appl.* 1939, 19 : 430-1.)

A SECOND REPORT ON THE TERMITES OF TRINIDAD, BRITISH WEST INDIES.

By A. M. Adamson.
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Introduction.

In 1937 I wrote a preliminary report on the termites of Trinidad, describing briefly the damage they do to buildings and indicating methods of control (1). In the present paper I add some records of species not dealt with previously, as well as some recent observations, and a few records from the neighbouring island of Tobago.

The number of species thus far recognised in my collection from Trinidad is about fifty-six and a few more will be found when a study of all of the collection is completed. About twenty of them have been found only once or twice, which suggests that a considerable number of species are yet to be discovered. Recent collecting has failed to add to the list in the following genera, each of which appears to be represented by a single species in Trinidad: *Heterotermes*, *Coptotermes*, *Rhinotermes* in the Rhinotermitidae, and *Cornitermes*, *Armitermes*, *Crepititermes*, *Termes*, *Cavitermes* and *Neocapritermes* in the Termitidae.

List of Trinidad Termites.

Kalotermitidae.

1-2. *Kalotermes* spp.
3. *Neotermes holmgreni* Banks.
4-7. *Neotermes* spp.
8-9. *Rugitermes* spp.
10. *Cryptotermes brevis* (Walker).
11. *Cryptotermes dudleyi* Banks.
12-13. *Cryptotermes* spp.
14. *Glyptotermes* sp.
15. *Calcaritermes nigriceps* Emerson.
16. *Calcaritermes* sp.

Rhinotermitidae.

17. *Heterotermes tenuis* (Hagen).
18. *Coptotermes testaceus* (L.).
19. *Rhinotermes longilabius* Emerson.

Termitidae.

20. *Cornitermes labralis* Holmgren.
21. *Armitermes holmgreni* Snyder.
22. *Obtusitermes* sp.
23. *Nasutitermes costalis* (Holmgren).
24. *Nasutitermes ephratae* (Holmgren).
25. *Nasutitermes guayanae* (Holmgren).
26. *Nasutitermes acajutlae* (Holmgren).
27. *Nasutitermes intermedius* Banks.
28-29. *Nasutitermes* spp.
30. *Subulitermes parvellus* Silvestri.
31. *Subulitermes snyderi* Emerson.
32. *Subulitermes baileyi* Emerson.
33-36. *Subulitermes* spp.
37. *Angularitermes nasutissimus* Emerson.
38. *Anoplotermes silvestrii* Emerson.
39. *Anoplotermes banksi* Emerson.
40. *Anoplotermes brevipilus* Emerson.
41-49. *Anoplotermes* spp.
50. *Crepititermes verruculosus* Emerson.
51. *Termes hispaniolae* (Banks).
52. *Termes* sp.
53. *Cavitermes tuberosus* Emerson.
54. *Neocapritermes angusticollis* Emerson.
55. *Microcerotermes arboreus* Emerson.
56. *Microcerotermes* sp.

List of Termites from Tobago.

Kalotermitidae.

1. *Neotermes holmgreni* Banks.
2. *Cryptotermes brevis* (Walker).
3. *Cryptotermes* sp.

Rhinotermitidae.

4. *Heterotermes tenuis* (Hagen).
5. *Coptotermes testaceus* (L.).

Termitidae.

6. *Nasutitermes costalis* (Holmgren).
7. *Nasutitermes ephratae* (Holmgren).
8. *Subulitermes* sp.
9. *Termes hispaniolae* (Banks).
10. *Microcerotermes arboreus* Emerson.

Kalotermitidae.

Kalotermes.

Two species of *Kalotermes* (*s. str.*), as yet undetermined, have been found in Trinidad. One of them is common in dead trees and logs on the small islands off the northwest coast, but has been found only twice on the main island of Trinidad. I have taken it also in Grenada, St. Vincent and Barbados. Only two colonies of the second species have been discovered in Trinidad, in dead tree-trunks near the sea. A single colony of the same species was taken at Carúpano, on the north coast of Venezuela, in May, 1937. Neither species appears to be of economic importance.

Neotermes.

The genus *Neotermes* is represented in Trinidad by three or four species, of which two occur abundantly.

Neotermes holmgreni Banks is very common in the lowlands in dead branches on trees. It has not been found at altitudes of over 500 feet. It appears to be capable of doing considerable damage to living trees. Invasion probably begins always in dead, dry wood but penetration of healthy tissues may follow. In a large avocado tree recently examined, the termites were attacking many of the largest branches as far as the main trunk, and their galleries extended into otherwise normal cambium, sapwood and heartwood. Similar injury to a live hogplum tree (*Spondias lutea*) has been observed. The large reddish-brown

alates of *N. holmgreni* appear frequently at lights in buildings, from April to November, but most often in May and June, at the beginning of the rainy season. They usually come in small numbers, not over two or three, between 10 and 11 p.m.

A second species of *Neotermes*, not yet determined, is common in dead wood in the rain-forests of the Northern Range of Trinidad. It appears to replace *Neotermes holmgreni* there, and it has not yet been seen below an altitude of 1,800 feet.

A third *Neotermes* is represented by a single colony found in the Northern Range at 2,000 feet altitude. A single alate collected at light by Mr. P. R. Stephenson at Mt. Harris, in the Central Range, in December, 1937, probably belongs to a fourth species, being rather small for any of the others.

Rugitermes.

Members of the small genus *Rugitermes* are extremely rare in Trinidad. A single colony of one species, and two colonies of one which is tentatively referred to this genus, have been found in the rain-forests of the Northern Range.

Cryptotermes.

Four species of the destructive dry-wood termites of the genus *Cryptotermes* have been collected in Trinidad. Three of them have been found attacking wood in buildings.

Cryptotermes brevis (Walker) is one of the two most destructive termites in Trinidad, occurring in the structural wood or furniture of a majority of buildings throughout the island, as already described (1, 2). I have recently found it in Tobago, doing extensive damage to buildings at Bacolet.

Cryptotermes dudleyi Banks has been found in Trinidad on two occasions in wood of buildings, and twice in dead trees. It appears to be one of the few species of termites that have extended their range from the Old World to the New. It was described from Panama in 1918, and in the Orient it is believed by Light (6) to range from the Philippines to Ceylon. Emerson (5) states that it was introduced to Panama, probably from the Orient some time before 1890 and that it has not established itself in wild situations there. It is therefore of interest to note that in Trinidad it was found in a dead tree stump in Maracas Valley, in a thinly populated district.

A third species of *Cryptotermes*, probably new, has been found in Trinidad on four occasions in wood of buildings and eight times in dead trees and logs outside. In Tobago it was found attacking the posts of a bungalow at Speyside.

The alates of *C. dudleyi* and the above undetermined species are very similar. They frequently appear in small numbers at lights in buildings, usually between 6 and 7 p.m., from March to October.

A fourth *Cryptotermes* has been collected twice in dead tree-trunks, near the sea at Balandra Bay.

Glyptotermes.

An undetermined species of the small genus *Glyptotermes*, possibly new, has been found five times in dead trees and logs, mostly in mountain forests. It was taken once in Tobago at 800 feet altitude.

Calcaritermes.

Calcaritermes nigriceps Emerson, described from British Guiana, has been found not uncommonly in dead wood in forests, mostly in the mountains. The darkly pigmented alates were taken in three colonies in April, May and August, and a single winged form was captured while swarming on 11th April, 1939, at about noon.

A second species of *Calcaritermes*, probably undescribed, is very common at low levels—it has not been seen at altitudes above 500 feet—in dead trees and logs. Alates appear frequently at lights in buildings, usually between 6 and 7 p.m., from March to November. Though common in the vicinity of buildings, this termite appears to be of no economic importance.

Soldiers of these two species of *Calcaritermes* have been observed to take up a defensive attitude in the narrow tunnels made for communication between the wider galleries. As in the case of *Cryptotermes*, the heavily armoured head of the soldier, square in front, is apparently designed to block these tunnels, the diameter of which is but slightly greater than that of the soldier's head, against intruders such as ants.

Rhinotermitidae.

Further collecting has failed to add to the three species previously reported in the family Rhinotermitidae.

Heterotermes.

Heterotermes tenuis (Hagen), as already described (1, 2), is ubiquitous and very destructive to susceptible timbers of all kinds in contact with the ground, or which it can reach by means of covered passages. This is well illustrated at the sites of the durability tests of local timbers against agents of decay in the ground, which were laid down by the Forest Department of Trinidad in 1937. All four of the test "graveyards" were heavily infested by *Heterotermes* within six months, and a large proportion of the pieces of susceptible timbers were destroyed within a year. During the second year of the tests the population of *Heterotermes* was somewhat reduced at all four "graveyards" but it has remained sufficiently high (in discarded test-pieces left for this purpose in the "graveyards", as well as in wood more recently attacked) to subject all the remaining timbers to a rigorous test. In 1937 and 1938, alates of *Heterotermes* were seen flying to lights in buildings in May, June, July and November, most often between 6.30 and 8 p.m., but also between 10 and 11 p.m.

Coptotermes.

Since the publication of my previous report, *Coptotermes testaceus* (L.) has been found in a few buildings, doing great damage, but it is still to be regarded as a much less frequent cause of damage than *Heterotermes*. The sporadic nature of its attacks and its irregular distribution are shown by its occurrence at the sites of the durability trials referred to above. It has not yet invaded the "graveyards" at Mt. Harris and Arena, though present in the surrounding forests. At Siparia and Port-of-Spain it was very abundant during the first six months of the tests, destroying a greater quantity of wood than *Heterotermes*, but during the second year, for no obvious reasons, it disappeared completely from both "graveyards".

Termitidae.

Nasutitermes.

The common builders of arboreal "carton" nests—*Nasutitermes costalis*, *ephratae* and *guayanae*—have been mentioned in a previous report. A fourth species, *N. acajutlae*, not hitherto recorded from Trinidad, has similar nesting habits. Two or three other species have been taken once or twice, and little has yet been discovered concerning their biology.

Nasutitermes acajutlae (Holmgren) is the largest member of the genus in Trinidad and the soldier is remarkable in having the head thickly covered with long bristles. The nests, which occur less commonly than those of the three species mentioned above, are the largest arboreal termite structures found on the island, attaining a diameter of over 4 feet. A queen from a nest of this size was 32 mm. long and 12 mm. in diameter. All of the nests that I have examined are approximately spherical, dark brown in colour, with a rough tuberculate surface, and similar in many respects to the nests of *N. costalis* and *guayanae*. When opening a nest of *N. acajutlae*, I have found the workers to bite with sufficient vigour to draw blood. The alates are pale yellow-brown and doubtless fly by night, like those of *ephratae* and *guayanae*.

In my previous report I mentioned the small, earthen, mound nests characteristic of the Aripo, Mausica and Piarco Savannahs, as belonging to an undetermined species of *Nasutitermes*. The builders of these mounds have proved to be *N. ephratae*, which elsewhere constructs "carton" nests high up on the trunks and branches of trees. This is an interesting case of change of habit with environment, the mound nests differing from the arboreal in form, composition and texture of surface as well as in location.

In Tobago *Nasutitermes costalis* and *ephratae* have about the same status as in Trinidad. Other species of the genus have not yet been taken in Tobago, though some of them probably occur there.

None of the species of *Nasutitermes* has yet been found to attack buildings in Trinidad, except in the case of a few old houses, in ill repair, which had been invaded by *N. costalis*, following on attack by other termites. All four of the commonest species, however, may damage fence-posts and other wood in the most exposed situations. In some of the durability trial "graveyards" already mentioned, *N. costalis* appeared after about six to twelve months; a considerable number of test-pieces have been attacked by it, but scarcely any have been recorded as destroyed by this species alone. The delay in its appearance is probably evidence of a preference for wood that has begun to decay.

Subulitermes.

The smallest and least conspicuous of the termites of Trinidad belong to the genus *Subulitermes*. The soldiers resemble on a reduced scale those of *Nasutitermes*, the head being drawn out into a long snout for the ejection of a defensive fluid, while the mandibles are reduced and apparently functionless. The genus is well represented in Trinidad, by about seven species, some of which occur abundantly. Most of them are of cryptic habit, living in the soil or in wood in an advanced state of decay, and not revealing their presence by exposed constructions. They are of no obvious economic significance, though they may play an important rôle in the final disintegration of dead wood and other plant remains, as well as in aeration of soil.

Subulitermes parvellus Silvestri is probably the commonest species in Trinidad. It has a wide range, from sea-level to the mountains of the Northern Range, though it appears to be most at home in dense forest, living in the soil and in soft, rotting wood. Alates have been taken in many colonies, from May to August.

Subulitermes snyderi and *baileyi*, both described from British Guiana by Emerson (4), occur less frequently and in smaller numbers than *parvellus*. About four other species, not yet determined and some of them probably new, have been collected in Trinidad, and a few more probably await discovery.

Angularitermes.

A single species of the remarkable genus *Angularitermes* was described by Emerson (4) from British Guiana as *N. nasutissimus*, because of the extraordinary length of the rostrum of the nasute soldier. In March, 1937 I found three soldiers and one worker of this species in a boring leading from the ground into a fallen palm trunk, in the Arena Forest Reserve. No further individuals were seen, though the entire trunk was chopped up, as well as all dead wood in the immediate vicinity, and the surrounding soil turned over, before the search was abandoned. This interesting species must be extremely rare in Trinidad, and Emerson records only two colonies found in British Guiana.

Anoplotermes.

In my last report scarcely any mention was made of the genus *Anoplotermes*, which proves to be the largest in number of species in Trinidad. The species in my collection probably exceed

ten and as several of them have been collected only once or twice, it may be assumed that others remain to be discovered. Many of them appear to be exclusively soil-dwelling, making no constructions other than mere underground excavations. The eggs of several species have been unearthed in small chambers a few inches below the surface of the soil, but a search for kings and queens in the vicinity has almost always proved fruitless. Little has been published about the habits of these and other termites of cryptic habit in the Neotropical Region.

Small termites of the genus *Anoplotermes*, especially *A. banksi*, are extremely abundant in the top-soil of forests in Trinidad. Wherever a search has been made, their subterranean tunnels, crowded with workers, have been found under almost every square foot of surface of the ground. These termites appear to swallow earth, after the manner of earthworms, and they probably play an important rôle in the disintegration of organic matter as well as in aeration of the soil. By consuming humus some termites may reduce fertility in certain soils, but in many cases they probably improve its physical and chemical characters for plant growth.

The possibility that some termites play a part similar to that of earthworms in relation to soil fertility has long been suspected (see for example a paper by Drummond, "On the termite as the tropical analogue of the earthworm", written in 1886), but the feeding habits of soil-dwelling termites have not been carefully investigated. A study of the problem, beginning with species of *Anoplotermes*, has recently been undertaken by the writer.

Termes (Mirotermes).

The only species of *Termes* (formerly *Mirotermes*) that I have collected in Trinidad is the common *T. hispaniolae*. Dr. A. E. Emerson informs me that he collected an undescribed species here and Dr. T. E. Snyder has sent me an unpublished record of *T. panamaensis* Snyder in Trinidad.

Termes hispaniolae was regarded as of little economic importance in Trinidad, but it has recently been found invading a wooden house in the vicinity of St. Augustine.

Microcerotermes.

Microcerotermes arboreus Emerson, the common and widespread builder of "dirt" nests on trees, fence-posts, &c., has recently been found attacking two newly built houses. One of these, in St. Augustine, stands on concrete pillars three feet high, up which numerous covered passages had been built; the removal of these and of all nests on trees in the vicinity has arrested the attack. In the second house, in Port-of-Spain, covered passages were built up walls inside the house within a few weeks of its erection. These records show that this species, though relatively rare in buildings, is capable of attacking them as readily as any other subterranean termite in Trinidad.

In Tobago *Microcerotermes arboreus* is as abundant as in Trinidad.

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GUMMING DISEASE OF SUGAR-CANE.*

Two papers were submitted on gumming disease at the recent International Sugar Cane Technologists' Congress. The first by C. G. Hughes (1), deals with the question of alternate hosts as presented in Queensland. By means of artificial inoculations with a hypodermic syringe he was able to show that a number of wild and cultivated members of the family *Gramineae* could carry the disease. Among the plants on which successful inoculations were made are dent and sweet corn, ten varieties of sweet and grain Sorghums, *Sorghum verticilliflorum*, Sudan Grass (*S. sudanense*), Johnson Grass (*S. halepense*), Para Grass (*Brachiaria mutica*), Elephant Grass (*Pennisetum purpureum*) and Guinea Grass (*Panicum maximum*). In the last only were the symptoms doubtful. Among these are species which grow in very moist situations and are, therefore, able to grow vigorously even during droughts. It is not to be concluded from these experiments that a natural infection of these hosts actually takes place.

The same aspect of the question as presented in Mauritius is discussed by G. Orian (2). He gives a somewhat detailed account of the evidence on which the conclusion is based that a disease found occurring naturally in maize, another disease of the palm *Dictyosperma album* and a third of the "broom bamboo" *Thysanolaena maxima*, are identical with the gumming disease of sugar cane, the organism being in all cases *Bacterium vascularum*. Cross inoculations between all these hosts by the various extracted pure cultures gave the corresponding symptoms.

(1) *Proc.*, p. 430. (2) *Proc.*, p. 437.

* *Int. Sug. Jr.*, Vol. XLI, No. 491, pp. 414-16.

THE BRAZIL NUT.*

THE Brazil nut tree is indigenous to the Amazon basin, where it is known as "castanheira", the nut itself being called "castanha do Para". There seems to be some doubt as to the exact botanical origin of the tree and more work on this aspect of the matter is desirable, particularly from the point of view of the introduction of the most suitable form for cultivation in regions outside its natural habitat. The nut of commerce is commonly referred to as being derived from *Bertholletia excelsa* Humb. and Bonpl., but a second species, *B. nobilis* Miers, has also been described.

The tree is an evergreen and when mature may attain a height of 120-150 ft. and a diameter of 4-6 ft. The flowers are yellowish-white or cream in colour and have six petals with numerous stamens. The fruits vary from about 2 to 5 lb. in weight and from 3 to 6 in. in diameter. A tough external envelope about ½ in. in thickness encloses anything from 12 to 25 nuts, according to the size of the individual fruits. Within the fruit the nuts are borne in two concentrically arranged rows.

The Brazil nut trade has roughly doubled since 1914. The United Kingdom and the United States are the chief consuming countries, production being almost entirely a Brazilian monopoly, though some nuts are obtained from Bolivia.

The Brazilian Industry.

Brazil nuts are at present obtained almost exclusively from trees growing wild in the states of Para and Amazonas, in which there are several important producing districts. Either the trees and the land are in definite ownership, or else harvesting rights are owned. Little in the way of cultivation is normally undertaken, but in more recent years some attention has been directed to the establishment of plantations.

The tree grows naturally in clumps or groves in the forest, which occur normally at some distance from the waterways as it does not thrive on swampy land. Some are found on raised ground close to the rivers.

In districts where the tree grows, the temperatures recorded show little variation from month to month. At Manaos, over a period of ten years, the mean monthly temperature is given as 81°F., the mean monthly maximum and minimum temperatures as 90°F. and 75°F., and the absolute maximum and minimum as 102°F. and 66°F. The average annual rainfall for the same locality is 77 in.; the wettest months are from December to May.

Flowering occurs from October to December in Para and from November to January in Amazonas. Maturity of the fruits is reached from 13 to 15 months after flowering, and harvesting is normally in progress from January to April, i.e. during the rainy season, although it may extend a little longer. As the principal demand for the nuts in the United States and in Europe occurs at Christmas the bulk of the crop has to be stored for some months. In two producing districts, however, Acre and Rio Negro, the crop begins to fall in November, and these districts are thus able to market some of the new crop during the Christmas season.

The extent of the production is governed by the price of the nuts themselves, by the value of other Brazilian forest products, and lastly and perhaps above all by transport facilities. There appears to be a relatively unlimited number of trees in the forests, but collectors cannot profitably work more than a certain distance from the rivers as water transport is the only means of evacuating the produce. It is of economic importance that the harvest time, which occurs during the rainy months, does not coincide with the busy season of the rubber industry.

The labour force is usually paid on the basis of the quantity of nuts brought into the employer's homestead. A single worker may collect half a hectolitre (about 50 lb.) or more of nuts per day, and the payment may be on the basis of about half the value of the nuts. The labourers lead a nomad life and wander through the forest in search of the fruits. On stormy or windy days it is considered unsafe to work under the trees on account of the size of falling fruits, and at such times the fruits previously collected are opened with a cutlass or rough hammer.

Nuts damaged when the fruits are opened must be discarded as if such nuts are mixed with sound ones, fermentation may set in and a whole consignment may be ruined. Damaged nuts may be eaten, or used locally for oil making. The fruits should also be collected as soon as possible after these have fallen, as the crop tends to deteriorate if the fruits are left lying on the ground for any appreciable time during the wet weather that is experienced at the time of harvest.

On account of the size of the trees harvesting by picking unfallen fruits is impracticable, and as only fully ripe fruits fall no difficulty is experienced in the Brazil nut industry over the collection of immature nuts.

The annual yield obtainable from a mature tree has been given as from 200 to 400 fruits, or 220 lb. of nuts. A tree may however produce 500 lb. or even 1,000 lb. of nuts in a single year.

Very little in the way of preparation or grading seems to be undertaken at the producing centres. After the fruits have been opened the nuts are spread out in the sun to dry, and may be washed and sieved according to size. In the washing process a quantity of nuts is usually placed in a basket which is then dipped into the river, when the bad nuts will float to the surface and can be eliminated. Grading is more commonly undertaken by the main exporters when the nuts reach such towns as Belem and Manaos.

* Extract from an article in the *Bulletin of the Imperial Institute*, Vol. XXXVII, No. 3, pp. 350-358, 1939.

The crop may be purchased in the interior by middlemen for ultimate sale to exporting merchants; the latter also maintain transport services on the rivers and buy direct from the producers. Various municipal and state taxes are payable on the crop exported.

Brazil nuts are classified according to size and district of origin. Three grades are recognised, which are of the following approximate dimensions:

Large —2½ in. to 2¾ in. long.
1½ in. thick.
64 nuts per kilo (25 per lb.).
30 nuts per litre weighing 490 gms.
Each nut about 16 gms. (just over ½oz.)

Medium —1¾ in. to 2¼ in. long.
38 nuts per litre.

Small —1¼ in. to 1¾ in. long.
64 nuts per litre.

Regarding the quantities of each grade produced, typical figures of exports from the port of Belem comprised 6 per cent. large, 54 per cent. medium, and 40 per cent. small.

Nuts for export should be fresh, i.e. on cutting the kernels should present a milky appearance. Cut samples containing over 90 per cent. of milky nuts are judged to be superior, over 85 per cent. as medium, and less than 80 per cent. as inferior. The practice of mixing old nuts with fresh ones is strongly condemned.

Among the producing districts, nuts from Paru and Jary have a reputation for quality and are said to command the highest prices. Whether this superior quality of the produce of these districts is due to more careful washing and preparation of the nuts after harvest, or to any intrinsic varietal superiority it is difficult to say.

The bulk of the crop is exported in the shell, but there is also an appreciable trade in shelled nuts, chiefly to the United States. Machines are available by means of which the nut can be removed whole from the shell.

Brazil nuts are liable to be adulterated with other forest nuts, more especially with nuts of *Lecythis* spp., commonly called monkey pot trees. The presence of such adulterants is considered to be undesirable unless the nuts are to be used locally for oil extraction, and regulations to prevent such adulteration have been in force for some years.

Establishment of Plantations.

Very little progress appears to have been made so far in the direction of the establishment of plantations in Brazil. It is advised that only fresh seed should be used, as dry nuts germinate but slowly. In Brazil the best time to sow is stated to be at the height of the cropping season, i.e. from January to March; the nuts germinate in two or three months. The young seedlings may be kept in nursery beds for a year when they will be just over 2 ft. in height; they are planted out in the field at a spacing of from 35 to 40 ft. apart. No special attention seems to be given to transplanting and early cultivation, no shade is employed and manuring is not normally practiced. At five years the trees will have attained a height of from 13 to 20 ft. and may be some 80 ft. high when twenty-five years old. The first flowers may appear when the trees are four years old, and some fruits may be borne the following year. though fruits are not usually produced from the first two or three seasons' flowers. An appreciable crop should be produced when the plantation is about twelve years old.

Composition and Uses.

The edible portion of the Brazil nut comprises a little over half of the weight of the nut as purchased in the shell, the percentage of kernel usually ranging from 51 to 53 per cent. It is somewhat richer in oil than most other dessert nuts but rather poorer in proteins. The following analysis is taken from Plimmer's *Analyses and Energy Values of Foods.*

	Brazil nuts Per cent.
Water	2.9
Ash	3.3
Fibre	2.1
Protein	13.2
Carbohydrate (by difference)	8.1
Fat	70.4

The vitamin content of the nuts is not outstanding. Those whose presence have been recorded are A, B (complex) and C.

The digestibility of the nuts has been investigated by Jaffa and that of the oil by Holmes. The latter states: "The high digestibility of Brazil nut oil and the relatively high digestibility of Brazil nuts as a whole, as reported by Jaffa, would indicate that from a dietetic stand-point these nuts are worthy the high place accorded them as food".

The chief use of Brazil nuts is for dessert purposes, for which unshelled nuts of large size are in demand. In Brazil the large nuts are generally regarded as being those of the highest quality, but this may partly be due to the fact that these receive more careful attention during preparation.

Brazil nuts are also largely employed for confectionery purposes and when used whole, as for example as centres for chocolates, the manufacturer prefers a relatively small nut. Such a requirement would have to be kept in mind when considering any development of a plantation industry.

Brazil nut oil is a liquid, semi-drying oil, resembling cotton-seed and sesame oils in its general characteristics. The oil, which possesses to some degree the flavour of the nuts, is eminently suitable for edible purposes, but in normal circumstances the value of the nuts is too high for economical extraction. In Brazil small quantities of the oil are expressed and used for lighting and cooking.

The Brazil nut tree is also valued for its hard and durable timber. The exploitation of the timber does not appear to be regarded with favour, however, on account of the fear of a permanent reduction of the nut crop; nevertheless it is said that trees tend to disappear in some of the more accessible localities as a result of cutting for timber.

Prospect of Production in Empire Countries.

The only part of the Empire in which the Brazil nut is indigenous appears to be British Guiana where it is stated to be plentiful in the Upper Essequibo and Rupununi districts. Schomburgk says that the tree stretches along the plains between Long. 57° and 68° W. and between Lat. 6° S. and 4° N., which would include the whole of the southern part of the country up to the Makarapan Mountains. It seems, however, to be most plentiful in the parts bordering Brazil. Schomburgk states that the tree seems to prefer a stony soil and to be seldom present at altitudes above 1,500 ft. or below 400 ft. The nuts are collected for local use, but transport difficulties from such remote districts under existing conditions are against their commercial exploitation. Few attempts have been made to cultivate the tree in British Guiana. It was planted at the Government Industrial School at Onderneeming in 1902, but growth was slow, and it appears that if any efforts are made in the Colony to grow a nut crop it is more likely that attention will be devoted to the Souari nut (*Caryocar nuciferum*), which has been grown successfully at Onderneeming and fruited at a reasonably early age.

The Brazil nut has been introduced into many tropical parts of the Empire, including Malaya, Ceylon, North Borneo, some of the West Indian Islands, Seychelles, and quite recently into Nigeria and the Gold Coast, but nowhere has production reached a commercial stage. The most promising results so far achieved have been obtained in Malaya, where the Brazil nut was first introduced about 1884. The Brazil nut has also been successfully established at Peradeniya and at Heneratgoda, Ceylon, since about 1880. Early introductions into North Borneo appear to have failed, but the Brazil nut was reintroduced to that Territory in 1931 and again in 1935 and now appears to be succeeding. The introduction to the Seychelles is comparatively recent, but the tree appears to thrive there and has been distributed to the public among economic plants issued from the departmental nurseries. In Jamaica the tree is established at the Botanic Gardens and in 1921 a single mature specimen was said to be growing well in the Botanic Gardens at St. Vincent. The tree is known in Trinidad and fruits well at the Botanic Gardens and also at the Government Farm, St. Joseph. The tree is recorded as growing in 1918 at the Botanic Station, Belize, British Honduras.

THE FERMENTATION PROCESS IN TEA MANUFACTURE.*

Tea Tannin and its Fermentation Products.

The conclusions reached by various investigators regarding the nature and structure of tea tannin in both green leaf and made tea have, so far, been somewhat contradictory. The problem has now been clarified to a certain extent as a result of investigations carried out at the Tocklai Experimental Station, Assam, India, on tea tannin and its fermentation products. The following article is a summary of the conclusions which have so far been reached.

From experimental evidence, tea tannin, prepared by extraction of the green leaf with boiling water, must be considered as a condensed tannin derived from l-epicatechin and gallocatechin. Since catechins undergo condensation on boiling in aqueous solution, it is likely that the tannins of the green tea leaf are not far removed from the parent catechins themselves, so that tea tannin in green leaf probably consists of a mixture of l-epicatechin, gallocatechin and their simpler condensation products.

During fermentation, oxidation of tea tannin takes place, and this oxidation is restricted to the catechol or pyrogallol nucleus only. These oxidized substances then undergo condensation with the formation of complex products, a theory which is supported by the fact that oxidized catechins undergo condensation very readily.

A study of the influence of temperature on fermentation, showed that, although the initial rate of tannin oxidation is accelerated by increasing the temperature, the total amount of tannin oxidized remains the same, since oxidation cannot proceed beyond an uptake of one atom of oxygen per molecule of tannin. The condensation process on the other hand is not limited in any such way. Presumably, the higher the temperature of fermentation the more highly condensed are the products of reaction. As an example, an increase in temperature from 25° to 40°C, whilst increasing the rate of tannin oxidation by only 20 per cent., increases the rate of condensation by 150 per cent. A marked difference in characters of infusions of teas fermented at these two temperatures would therefore be expected. In confirmation of this, it has been shown that there is an inverse correlation between quality and temperature of fermentation at temperatures of 70°F. and over.

The tannins of green tea are a fairly complex mixture, but the tannins of made tea are even more complex. Under normal manufacturing conditions, oxidation of the tannins originally present in the green leaf is about 80 to 90 per cent. complete, and these oxidized tannins are present in the form of a wide range of condensation products. The possibility of isolating definite

* From the Tocklai Experimental Station, Indian Tea Association, Cinnamara, Assam, India.

compounds to which the various characters of the tea infusion may be attributed is therefore, rather remote. All that can be hoped for is a separation of the tannin substances into fractions of greater or less pungency, colour, and other such qualities. This has already partially been achieved. Tannins in made tea are precipitated by acids and by salts, and apparently the ease of precipitation increases with the extent to which the oxidized tannins have condensed. As an example, green leaf infusions give no precipitate with dilute acids, whereas an infusion of made tea gives a precipitate of tannin when slightly acidified with sulphuric acid.

Experimental evidence indicates that the acid-precipitable fraction represents some of the more highly condensed tannins which are responsible for the dark colour of the infusion. Too great a proportion of this fraction might be expected to produce a liquor remarkable for its depth of colour alone and lacking in the astringent character due to the presence of less highly condensed products. This expectation is borne out by a correlation which has already been established between valuation and acid-soluble tannin on teas from any one estate. If quality of leaf and conditions of manufacture are reasonably constant, the acid-soluble tannin content seems largely to determine the value of the made tea.—(Extracted from an article by C. J. Harrison and E. A. Haughton Roberts. *Biochem. Jr.*, Vol. XXXIII, p. 1408, 1939.)

H. F. B.

MISCELLANEOUS NOTES.

African Palms.

An exhaustive account of the occurrence, nativity, distribution and economic uses of the more important African Palms has recently appeared (Barret, *der Tropenpflanzer*, 1939, 42, 185).

Africa is said to be very poor in palms but it is characterised by a number of endemic genera. Of these *Juboeopsis caffra* is very interesting on account of its close affinity to the coconut palm. The Oil Palm (*Elaeis guineensis*), is the most important of the African palms. The cultivated forms are very widely distributed while the true wild forms are found only in deep inland forests. Coconut (*Cocos nucifera*), date (*Phoenix dactylifera*), palmyra (*Borassus oethiopium*) and cabbage palms are also common. Of the other palms *Raffia*, so called on account of the fronds, with its 30 species, forms the richest genus. They are gigantic palms with pinnatifid leaves and fronds which individually measure about 20 metres. The well-known *Raffia* bast is obtained from *R. Ruffia*, which is very easy to cultivate and grows exceptionally rapidly. The sweet fruits of the flabellate palms, *Hyphoene*, are highly valued by the natives. The *Rattan* is poorly represented in the African forests. The pigmy palm, *Chamoerops humilis* is found wild. Its finely divided petiole gives the export article, *crin d' Afrique*. The vegetable horse-hair from the petiole, used for stuffing pillows, &c., is immune from the attack of insects. There are references to many other palms, the numerous uses to which they are put by the African natives, and their industrial possibilities.

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Grass Drying.

A report on fodder conservation with special reference to grass drying by E. J. Roberts has been published by the Agricultural Research Council (H. M. Stationery Office. 2*s*.). This is the third report on the subject, and embodies the results of the most recent experiments carried out with the co-operation of agricultural organisers, colleges and experimental farms in Great Britain. A detailed account of grass-drying machinery and equipment is given, and comparison made with the various processes of artificial drying in other countries. There seems to be little doubt that the conservation of young grass is sound in principle, as it is then at its maximun nutritive value, and feeding trials show that it can largely replace concentrates. The question of the profitableness of grass-drying, however, cannot be answered so simply, as it depends both on the quality of the product and also on other matters such as the market value of the concentrates which it is to substitute, and whether the grass would have been utilized in some other manner or wasted through occurring at a time of surplus growth. The indirect advantages of the process, such as improvement of the sward, control of thistle, &c., must not be overlooked, nor the fact that the lower grades of dried grass are of higher value than the best hay. Profit-making, however, in this as in many farming enterprises, depends to a very large extent on the skill of the individual.—(*Nature*, Vol. 144, No. 3647, p. 545-46, 1939.)

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The Pissaba Palm.

The palm, *Attalea funifera* Mart., is a native of Brazil and during the 1914-18 war became of such importance for the oil of its nuts that Brazil has forbidden the export of the unshelled nut fearing that its culture might become established in foreign countries. Though found on many different soils the preferred habitat is in the neighbourhood of rivers, but it is found also well inland in the bushy situations where the climate is moist and equable. Each palm produces 2 to 6 spathes bearing each 200 to 300 nuts, varying in size from a lemon to a small coconut. The palm grows fast and if cut down soon re-establishes itself by suckers from the roots. The tree is not cultivated and at present this is scarcely necessary since the collected crop is never fully disposed of or gathered. Among the reasons for the failure to exploit this crop to the full are shortage of labour, and until recently, shortage of machinery capable of dealing with the very hard nuts. The kernels yield an oil closely resembling coconut oil, but 100 kilogrammes of nuts produce only 9 kg. of kernel or 5 to 6 kg. of oil. The husks are used as fuel to drive the extracting machinery and carbon made from them can be used in gas masks.—(*Agron. colon*, 1938, 27 : 78-82.)

CHEMICAL NOTES.

(Compiled by the College Department of Chemistry and Soil Science.)

Seed Germination in Tap Water.

Borthwick, United States Department of Agriculture, has noted that germination of seeds of *Hypericum perforatum* was distinctly more rapid in distilled water than in tap water. Mixing only 1 per cent. of tap water with distilled water, or soaking the seeds in tap water for only one hour, induced a measurable delay. The effect is due to the calcium of tap water which acts probably upon the permeability of the membranes. —(*Ind. Eng. Chem., News Edit.*, Vol. 16, No. 1.)

* * *

Fixation of Colloidal Ferric Hydroxide by Soil Clay.

An electropositive ferric hydroxide in contact with electronegative clay results in the complete fixation of the iron by the clay. As soil clay is normally electronegative, ferric oxide can only migrate in clay soils in an electronegative form; in this form its mobility is strongly inhibited by the pressure of high concentrations of calcium salts in the soil solution, but not by soil alkalinity. In practice, for the prevention of chlorosis, compounds of electronegative iron should be used and applied in winter, i.e. when the concentration of calcium salts in the soil solution is at its minimum.—(*Soils and Fertilizers*, I, No. 2. p. 52.)

* * *

Effect of Nitrogenous Fertilizers on the Calcium Status of Soil.

In an article by A. N. Lewis which appeared in the *Jr. of Agr. Sc.*, XXVIII, pt. 2, pp. 201-202 the results of an experiment, conducted over one cycle of a four-course rotation, to study the effects of nine nitrogenous fertilizers on crops and soil, are described. All the crops give fairly good responses to nitrogen, but in no case was there a significant difference between the effects of the various nitrogenous fertilizers. The "recovery" of added nitrogen was about 40-50 per cent. with all the fertilizers. Figures are given for the changes in exchangeable CaO content of the soil. The results confirm Crowther and Basu's deduction that "the loss of calcium exceeds that for equivalent nitrogen added as nitrate by an amount equivalent to the excess of anions over the cations in the added fertilizer, all added nitrogen being regarded as nitrate and all carbon and phosphates being ignored."

The fact that phosphate should be ignored, is shown by results for mono-and diammonium phosphates. Precipitation of phosphates in the soil almost certainly involves removal of calcium from the exchange complex, but the calcium in such precipitated phosphates is exchangeable. Since phosphate has no effect on calcium status, it is clear that fertilizers based on ammonium phosphates remove less calcium from the soil than do mixtures based on ammonium sulphate and superphosphate.

Oxidizing-Reducing Activity of Tissues as a Biological Factor in Soils.

Ability of leaves of cabbage varieties to oxidize ascorbic acid increases, and to reduce dehydroascorbic acid decreases, with increase of the normal growing period of the variety. The oxidation-reduction system in the tissues is closely related to sucrose activity, and is an important factor determining the evolution of plant forms, notably their earliness.—(*Soils and Fertilizers*, I, No. 2 p. 51.)

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Factors affecting Protein Content of Leaves.

In the first of a series of investigations on nitrogen metabolism in plants, Petrie and Wood have studied the relation between the content of proteins, amino-acids and water in leaves (*Ann. Bot.*, New Series, 2, No. 5). Experiments were performed on pure-line grasses, *Phaloris tuberosa* and *Lolium multiflorum*. The results obtained suggest that, in certain respects, the protein content of leaves varies directly with amino-acid and water content, and evidence was also obtained that the protein content increases with the pH of the expressed sap. It is suggested that the rate of formation of protein from amino-acids decreases with a reduction in water content, though it has not yet been established whether this decrease is due to decrease in protein synthesis or increase in protein hydrolysis, or both.—(*Nature*, Vol. 141, No. 3567, p. 478.)

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Non-setting of Pears.

The following abstract has bearing on the important problem of fruit-shedding in general, particularly that of young cacao and citrus fruits.—Ed.

Certain varieties of good quality pears blossom profusely, but are most irregular in setting their fruit. D. N. Srivastava (*J. Pom. and Hort. Sci.*, 16, 39; 1938) has investigated the problem at East Malling, using one free-cropping variety (Conference) and two shy-cropping varieties (Doyenné du Comice and Pitmaston Duchess). Two waves of dropping were observed, (i) a very early shedding of non-fertilized flowers, (ii) a late and comparatively light dropping of partially-developed fruits, popularly known as "June drop". The main cause of "June drop" did not appear to be lack of fertilisation, since plenty of apparently healthy seeds were found in most of the fruits dropped. Individual fruit size was correlated with length of life on the tree, the larger fruits remaining attached longest, from which it is inferred that dropping is *due to competition for nutrients*. Cutting back the main branches to eight year old wood increased the set of fruit the same year, but reduced the number of fruit buds the following year. Ringing increased fruit-bud formation but did not improve the set of fruit, whilst bending over and tying down the main branches gave variable results both for fruit-bud formation and for fruit set. It is thought that the problem is a nutritional one.—(*Nature*, No. 3578, p. 979.)